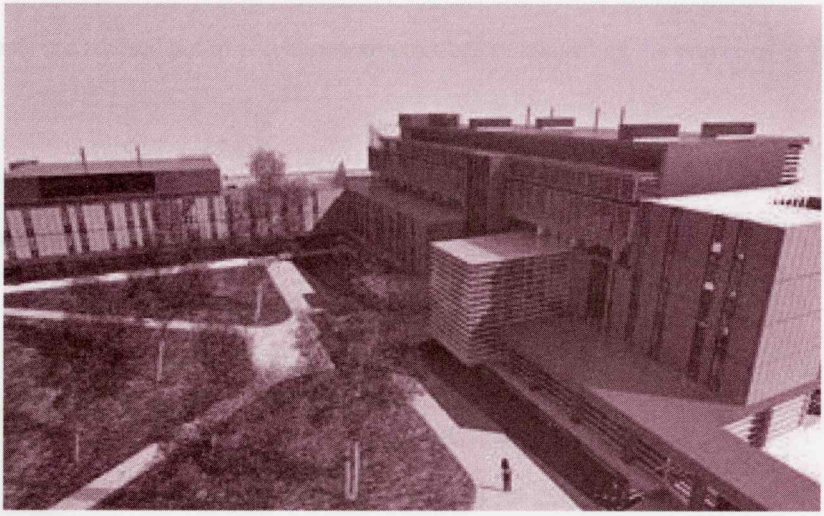
Chemistry and Biochemistry

Faculty of Arts and Science

Course Guide



Concordia
UNIVERSITY

Real education for the real world

Chemistry and Biochemistry

Faculty of Arts and Science

Course Guide

CONCORDIA UNIVERSITY

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

COURSE GUIDE

This guidebook was prepared to give the prospective student an overview of the Department, the facilities and the programmes. **Efforts have been made to make this Course Guide as complete and accurate as possible. However, it has been prepared months in advance of the 2006-07 academic year and information contained herein is subject to change. The Official University document is The Undergraduate Calendar.**

Students are advised not to purchase textbooks before consulting the professor at the first class.

Questions may be directed to:

The Department of Chemistry and Biochemistry

Loyola Campus

Richard J. Renaud Science Complex

7141 Sherbrooke Street, West, Room SP-201.01

Montreal, Quebec H4B 1R6

Tel: (514)848-2424, Extension 3366

Web Site Address: http://artsci-ccwin.concordia.ca/chem/chem.html

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The Science of Chemistry

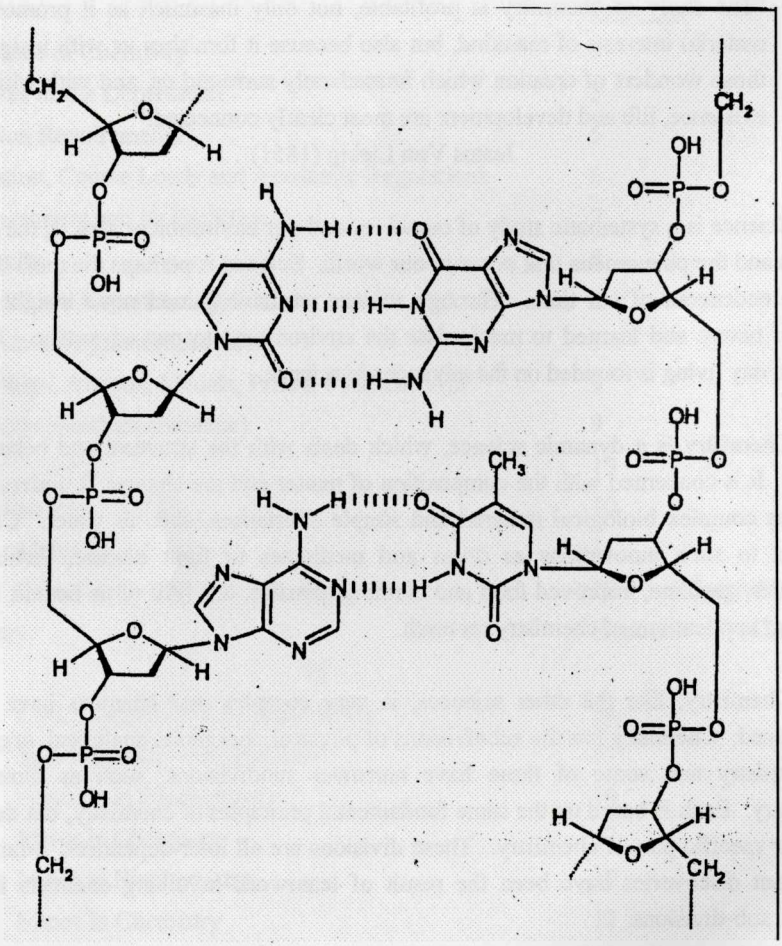
> "The study of chemistry is profitable, not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us with insight into those wonders of creation which immediately surround us, and with which our existence, life and development are most clearly connected."
>
> Justus Von Liebig (1851)

Science is a systematic study of ourselves and our environment, that is, the physical objects and the phenomena that occur in our world. Science is perhaps the most dominant human endeavour of our time. Through science we have gained some insight into the laws of nature and learned to manipulate the environment to our advantage. Much of modern day living is founded on the advances in science.

Chemistry is a dynamic science, which deals with the structure and behaviour of matter. It is concerned with the composition of matter and the changes it undergoes, this includes complex biological material and simple substances, such as water. Chemistry has led to such innovations as drugs and medicines to fight disease, fertilizer and pesticides, gasoline, improved food and clothing, plastics, etc. All of us benefit from the practical applications of chemistry research.

Chemistry, like the other sciences, is very complex and chemists have become specialized. Chemistry has the subdivisions of physical, inorganic, analytical, organic and biochemistry and some of these have narrower subdivisions, such as bioinorganic chemistry. Each is based on the same fundamental principles of chemistry, but deals with a rather specific part of chemistry. These divisions are all inter-dependent. Many of the important discoveries have been the result of teamwork involving chemists from the various sub-divisions.

DNA : THE MOLECULE OF HEREDITY



The above is a simplified schematic partial structure of a nucleic acid called deoxyribonucleic acid (DNA), the molecule of heredity, which was elucidated through the co-operation of all branches of chemistry. Biochemists isolated the compound, analytical chemists learned its composition, organic chemists studied the structure of components and synthesized models of it. The physical chemists elucidated the overall structure of

this huge molecule,

using physical methods like X-ray crystallography, and biochemists again studied its function in transmitting all hereditary properties of all living organisms from generation to generation. The importance of all this knowledge cannot be overestimated. The researcher, in close co-operation with colleagues continues to establish the intricate details of the correlation between structure and function.

OBJECTIVES OF THE DEPARTMENT AT THE UNDERGRADUATE LEVEL

The Department's aim is to offer the best undergraduate education in chemistry or biochemistry whether it is for a student who is intending to be a specialist, or one who is taking courses in chemistry as a requirement of some other career or for general interest. The faculty and facilities of the department are chosen with this aim in mind. Students are encouraged to meet individually with faculty members.

ADMISSION REQUIREMENTS

Quebec students usually enter the first year of the 90-credit programme after completing the two-year CEGEP programme. These students are expected to have completed the "Science Profile" as established through joint action of the Quebec universities and the provincial Department of Education. This profile includes the following courses: MATH: Differential & Integral Calculus I and Differential & Integral Calculus II; PHYS: Mechanics, Electricity & Magnetism and Waves & Modern Physics along with their labs; CHEM: General Chemistry I, and General Chemistry II; and BIOL: Introductory Biology. Graduates of the three-year CEGEP technical programme are also admissible.

Students from outside the province may also apply for admission. They may be admitted directly to the 90-credit programme or to an extended credit undergraduate programme depending upon the qualifications submitted. Consult the University Calendar for details.

Students who have not completed collegial studies and are over 21 years of age may apply for admission provided they meet the other criteria as a mature student. Students who wish to use the alternative entry provisions should consult the "Mature Student Programme" in the University Calendar.

All students must make sure that they follow the requirements set out in their letter of admission.

More detail is available in Section 13 of the Undergraduate Calendar.

REGISTRATION, COURSE LOADS AND ACADEMIC REGULATIONS

Each student will receive a package of information regarding the Registration process, which includes the registration dates. Students must see a Department Advisor who will help in choosing the courses and planning their programme. Unless you are a returning student it is mandatory to have an advisor approve your courses before Registration. You must make an appointment with an advisor:

Telephone: 848-2424, Ext. 3355

Make sure you bring a copy of your academic record and your letter of admission when you meet the advisor.

The normal course load for a full-time student is 30 credits for the academic year. (Note: enrolling in less than 24 credits in an academic year will make a student ineligible for many scholarships, bursaries and loans).

To request permission for a course overload, course substitution or to take a course without the required prerequisite, a student must obtain a Departmental Student Request form from SP-201.01. When the form has been filled in and the appropriate documents attached, it should be given to the Receptionist in room SP-201.01. Please read the Undergraduate Calendar for deadlines (Section 11) and regulations (Section 16) regarding course changes, withdrawals, etc. Make sure that you understand the Degree Requirements (Section 31.003) and Academic Performance Regulations (Section 31.003.1) for the Faculty of Arts and Science.

THE DEPARTMENT AND ITS FACILITIES

A list of the full-time faculty members in the department is shown on the opposite page. Although most courses are taught by full-time faculty, there are a variable number of adjunct professors and part-time lecturers. There are over 18 support staff, which includes technicians, secretaries, laboratory assistants, etc. The faculty teaches and does research in the major areas of chemistry and biochemistry.

The department's teaching and research laboratories are located at the Loyola Campus.

Among the major facilities accessible to faculty and students are the Centre for Research in Molecular Modeling, the Biological Mass Spectrometry Facility with special expertise in biomolecule analysis by LC-MS, an NMR laboratory, and the Centre for Structural and Functional Genomics.

The department offers graduate programmes at the master and doctoral levels. Full details of these are found in the Graduate Faculty Calendar or through the department's Graduate Programme Director. The faculty is actively involved in research in Analytical Chemistry, Biochemistry, Inorganic Chemistry, Physical Chemistry and Organic Chemistry and directs master and doctoral students in their thesis work. Our undergraduate students have a first-hand opportunity to engage in a research project with a faculty member of their choice in their final year.

FACULTY

Chair and Professor

M.F. Lawrence

Professors

P.H. Bird
J.A. Capobianco
A.M. English
R. Le Van Mao
R. Le Van Mao

Associate Professors

G. Dénés
P. Joyce
H.M. Muchall
G.H. Peslherbe
J. Powlowski
C. Skinner
J. Turnbull

Assistant Professors

L. Cuccia
P.G. Merle
C. Rogers
S. Robidoux
C. Rogers
C. Wilds

Part-Time Faculty

J. Fraser
E. Ghobadi
M.McClory
B. Pant
D. Pocock
L. Sahlman
G. Sunahara

Distinguished Professor Emeritus

M. Doughty
O.S. Tee

UNDERGRADUATE DEPARTMENT ADVISOR

Ms. D. Gordon
Office: SP-275.01 (Science Complex) Tel. : 848-2424, Ext. 3355
Email: dgordon@vax2.concordia.ca

Dr. P.H. Bird
Office: SP-275.05 (Science Complex) Tel.: 848-2424, Ext. 3367
Email: birp@vax2.concordia.ca

Please note that unless you are a returning student in good standing it is mandatory to see the department advisor (Ms. Gordon) before registering for courses. It is advisable to make an appointment.

CHEMISTRY/BIOCHEMISTRY COOPERATIVE EDUCATION PROGRAMME ACADEMIC DIRECTOR

Dr. S. Robidoux
Office: SP-201.15 (Science Complex) Tel.: 848-2424, Ext. 3377
Email: robidoux@vax2.concordia.ca

SCHOLARSHIPS AND FINANCIAL AID

A number of scholarships and prizes are available to students in the Department. Some of these are awarded before starting the programme of study at Concordia, such as, Entrance Scholarships, while others are awarded during the course of studies, such as, In-Course Scholarships. There are also Federal and Provincial Loans and Bursaries for eligible candidates. Further information is available in Section 18.7 of the Undergraduate Calendar.

THE COURSE NUMBERS

Course numbers consist of three digits. The first digit is an indication of the level of the course. Two hundred level courses are normally taken during the first year and will have Chemistry 205 and 206 and possibly other 200 level courses as prerequisites. Three hundred level courses are normally taken during second year. These will have 200 level courses and possibly some at the 300 level as prerequisites. The 400 level courses are taken in the final year and will have 300 level courses as prerequisites. They may require some 400 level courses to be taken previously or concurrently.

Students are advised to note the prerequisites carefully when planning their programmes.

The second digit in the course number indicates a field of chemistry. A zero indicates a field of general interest, 1 designates analytical chemistry, 2 designates organic chemistry, 3 physical chemistry, 4 inorganic chemistry, 5 a research course, 7 biochemistry, 8 industrial or environment chemistry and 9 instrumentation.

The third number in the numbering sequence is used to designate a sequence number of courses within a field. For example, at present, the number 234 would indicate the first course in physical chemistry at the introductory level.

SUMMER COURSES

There are a limited number of courses offered in the summer session. Most are courses of the second semester of the second year, offered as part of the Chemistry/Biochemistry Coop programme schedule. Other students may enrol in these courses if there is space available.

DEPARTMENT PROGRAMMES

The Department offers a variety of programmes at different levels to suit the particular needs of the student. The different areas are Chemistry and Biochemistry.

The different levels are the **Honours, Specialization, Major** and **Minor** programmes. Traditionally Canadian universities required an Honours degree to qualify for admission to a graduate programme. In the Quebec system the Specialization has replaced the Honours programme as the entrance requirement. The difference between the Honours programme and the Specialization programme is the higher performance level demanded in the Honours programme (See Undergraduate Calendar Section 31.003) and the inclusion of the Research Project and Thesis (CHEM 450), which requires independent research work of the student and an oral defence of the thesis before the Department. The Specialization in the chemistry programme has the Independent Study and Practicum (CHEM 419), where the student carries out independent study and practical work under the direction of a faculty member. The work is presented to the Department in the form of a scientific poster.

Notes: 1) The **Order of Chemists of Québec** has fully accredited the curricula of i) Honours in Chemistry; ii) Honours in Biochemistry;

iii) Specialization in Biochemistry; iv) Specialization in Chemistry.
Upon satisfactory completion of any of the above-mentioned programmes, a graduate is eligible for membership in the Order. Students are responsible for satisfying their particular degree requirements. A working knowledge of French is required. (The Quebec Order of Chemists regulates the practice of both chemists and biochemists in Quebec.)

2) Many professors recommend, and some require that students in these courses attend or have attended a **seminar on plagiarism** and the ethical use of information sources. For more information, see the beginning of this section on individual course descriptions.

Major/Minor

These programmes do not provide a sufficient depth in chemistry to pursue a career in chemistry. However, they may be combined with programmes in other disciplines where a knowledge of chemistry is useful for the student's chosen career. The major is essentially the core programme, whereas the minor is 24 credits chosen to form a coherent group of courses to complement the student's other area of study.

Exemptions

A student may be exempted from one or more of the introductory courses, on the basis of work done at CEGEP level. Where exemptions are given, replacement courses must be chosen with the approval of a Department Advisor. In the case of certain programmes approved by the Order of Chemists of Quebec, the courses must be replaced with an equivalent number of credits in the same sub-discipline of the exemptions.

The following paragraphs describe the course composition of these programmes:

(Note: A description of each course is given after the section on programmes.)

As previously noted a student must successfully complete 90 credits of course-work to fulfil the requirements for a B.Sc. The difference in credits

between 90 and the programme requirements is made up from elective and General Education courses (Section 31.004 of the Undergraduate Calendar). In the Faculty of Arts and Science a student must successfully complete, at least, 24 credits outside of the discipline or department.

The following **"CORE COMPONENTS"** are an integral part of the programmes as noted in each case.

CORE COMPONENT FOR CHEMISTRY (45 credits)

		Credits
CHEM 217	Analytical Chemistry I	3
CHEM 218	Analytical Chemistry II	3
CHEM 221*	Organic Chemistry I	3
CHEM 222*	Organic Chemistry II	3
CHEM 234	Physical Chemistry I	3
CHEM 235	Physical Chemistry II	3
CHEM 241	Inorganic Chemistry I	3
CHEM 242	Inorganic Chemistry II	3
CHEM 271	Biochemistry I	3
CHEM 312	Analytical Chemistry III	3
CHEM 324	Organic Chemistry III	3
CHEM 325	Organic Chemistry IV	3
CHEM 333	Physical Chemistry III	3
CHEM 341	Inorganic Chemistry III	3
CHEM 393	Spectroscopy and Structure of Organic Compounds	3

*For students entering with the CEGEP equivalents, these credits must be replaced with an equivalent number of other Organic Chemistry credits.

SPECIALIZATION IN CHEMISTRY (60 Credits)

Core Component for Chemistry	**45**
CHEM 495 Modern Spectroscopy	3
CHEM 419*Independent Study and Practicium	6
Additional credits in Chemistry‡	6

*With departmental permission, the student may substitute CHEM 450 for CHEM 419.

‡It is recommended that these courses be at the 400 level.

HONOURS IN CHEMISTRY

An Honours in Chemistry programme consists of completion of the requirements of the Specialization in Chemistry, with the election of CHEM 450 as the senior research project.

To enter an Honours programme, students must apply to one of the Department Honours Advisors, Dr. C. DeWolf, Tel. 848-2424, Ext. 3378, email: cdewolf@alcor.concordia.ca or D. Gordon, Tel. 848-2424, Ext. 3355, email: dgordon@vax2.concordia.ca, after they have completed 30 credits at Concordia, (but not requiring fewer than 30 credits to graduate). To enter and remain in the Honours programme, a student must maintain an average of "B" in all courses of the Honours component of the programme. No grade less than a C (2.0) in any core or elective course. A minimum average of "B" (3.0) Cumulative GPA on record upon graduating. Honours students are encouraged to attend departmental seminars.

See Section 31.003 of the Undergraduate Calendar.

Honours in Chemistry (60 Credits)

	Credits
Core Component in Chemistry	**45**
CHEM 495 Modern Spectroscopy	3
CHEM 450 Research Project and Thesis	6
Additional Credits in Chemistry‡	6

‡It is recommended that these courses be at the 400 level.

CORE COMPONENT FOR BIOCHEMISTRY (48 Credits)

	Credits
BIOL 261 Molecular and General Genetics	3
BIOL 266 Cell Biology	3
BIOL 364 Cell Physiology	3
BIOL 368 Genetics and Cell Biology Lab	3
CHEM 217 Analytical Chemistry I	3
CHEM 218 Analytical Chemistry II	3
CHEM 221*Organic Chemistry I	3
CHEM 222*Organic Chemistry II	3
CHEM 234 Physical Chemistry I	3
CHEM 235 Physical Chemistry II	3
CHEM 241 Inorganic Chemistry I	3
CHEM 271 Biochemistry I	3
CHEM 324 Organic Chemistry III	3
CHEM 335 Biophysical Chemistry	3
CHEM 375 Biochemistry II	3
CHEM 393 Spectroscopy and Structure of Organic Compounds	3

*For students entering with the CEGEP equivalents, these credits must be replaced with an equivalent number of other Organic Chemistry credits.

SPECIALIZATION IN BIOCHEMISTRY (69 Credits)

		Credits
Core Component for Biochemistry		**48**
CHEM 312	Analytical Chemistry III	3
CHEM 325	Organic Chemistry IV	3
CHEM 477	Advanced Lab in Biochemistry	3
BIOL 367	Molecular Biology	3
BIOL 466	Advanced Lab in Molecular Biology	3
and	6 Credits* chosen from:	
CHEM 470	Environmental Biochemistry	3
CHEM 471	Enzyme Kinetics & Mechanism	3
CHEM 472	Chemical Toxicology	3
CHEM 475	Protein Engineering and Design	3
CHEM 478	Hormone Biochemistry	3
CHEM 481	Bioinorganic Chemistry	3
CHEM 498	When Appropriate	3

*Note: 3 Credits may be replaced by a 400-level course in Chemistry or by a 400-level course in Cell & Molecular Biology

BIOL 441	Plant Biochemistry	3
BIOL 461	Advanced Genetics	3
BIOL 462	Immunology	3
BIOL 464	Advanced Cell Biology	3
BIOL 465	Biology Regulatory Mechanisms	3
BIOL 468	Gene Structure	3
BIOL 469	DNA Repair	3
BIOL 470	Microbial Physiology	3
BIOL 498	When Appropriate	3

HONOURS IN BIOCHEMISTRY (72 Credits)

		Credits
Core Component for Biochemistry		**48**
CHEM 312	Analytical Chemistry III	3
CHEM 325	Organic Chemistry IV	3
CHEM 450	Research Project and Thesis	6
BIOL 367	Molecular Biology	3
CHEM 477	Advanced Lab in Biochemistry	3
or		
BIOL 466	Advanced Lab in Molecular Biology	3
and	6 Credits* chosen from:	
CHEM470	Environmental Biochemistry	3
CHEM 471	Enzyme Kinetics & Mechanism	3
CHEM 472	Chemical Toxicology	3
CHEM 475	Protein Engineering and Design	3
CHEM 478	Hormone Biochemistry	3
CHEM 481	Bioinorganic Chemistry	3
CHEM 498	When Appropriate	3

*Note: 3 Credits may be replaced by a 400-level course in Chemistry or by a 400-level course in Cell & Molecular Biology

BIOL 441	Plant Biochemistry	3
BIOL 461	Advanced Genetics	3
BIOL 462	Immunology	3
BIOL 464	Advanced Cell Biology	3
BIOL 465	Biology Regulatory Mechanisms	3
BIOL 468	Gene Structure	3
BIOL 469	DNA Repair	3
BIOL 470	Microbial Physiology	3
BIOL 498	When Appropriate	3

NOTE: Students must meet the University regulations concerning the Honours degree (see page 16 of this booklet and Section 31.003 of the University Calendar). Honours students in second year and beyond are encouraged to attend departmental seminars.

MAJOR IN CHEMISTRY (45 Credits)

This programme is composed of the courses described in the Core Component. With prior approval of the Department Advisor, courses in related fields may be used as substitutions up to a maximum of 9 credits.

MAJOR IN BIOCHEMISTRY (48 Credits)

This programme is composed of the courses described in the Core Component. With prior approval of the Department Advisor, courses in related fields may be used as substitutions up to a maximum of 9 credits.

MINOR IN CHEMISTRY (24 Credits)

This programme consists of courses chosen from the Department's offerings that form a coherent pattern to complement the student's other areas of interest. The courses chosen must have prior approval by a Department programme advisor.

COOPERATIVE EDUCATION PROGRAMME

The "Coop" Programme in Chemistry/Biochemistry has the same academic course requirements as the Honours or Specialization programmes taken by "regular stream" undergraduates. However, Coop students alternate their academic semesters with off-campus paid work terms in government or industrial laboratories where they are employed as chemists/biochemists in training. Students who are above average academically, and interested in the Coop Programme should refer to the announcement in the Undergraduate Calendar, Section 31.515. More specific information may be obtained from the Director of the Chemistry/Biochemistry Coop Programme, Dr. Sébastien Robidoux, Tel. 848-2424, Ext. 3377, Email: robidoux@vax2.concordia.ca, or from the Institute for Cooperative Education (Telephone: 848-2424, Ext. 3950).

SCIENCE COLLEGE

Students planning to register in one of the programmes of the Department might consider joining the Science College. In the Science College students will gain an understanding of several areas of science while specializing in one that they choose. It is an opportunity to become acquainted with science as practiced and understood by scientists today. The goals of the Science College are to provide an opportunity for experience in a research environment, for thinking about the nature of science, and for becoming aware of the style and content of the various scientific disciplines. Students planning to register in a Specialization or a Major in the Department of Chemistry and Biochemistry are eligible for admission to Science College provided they meet the other entrance requirements of the College. See Section 31.550 of the Undergraduate Calendar or telephone 848-2424, Ext. 2595.

COURSE DESCRIPTIONS

Note: This list of courses does not imply that all of these courses will be offered in any particular year. Students must refer to the current schedule of courses for this information.

This section contains general descriptions of course contents. The names of the instructors are those that have taught the course recently and there may be changes, depending upon scheduling and workloads. No textbooks are listed. Students are cautioned against buying textbooks, references, etc. without the advice of the instructor at the first class.

Courses that consist of both laboratories and lectures require that a satisfactory performance be obtained in each of the components for successful completion of the course.

Seminar on the Appropriate use of Information Sources and the Academic Code.

In response to a growing number of cases where students have been penalized for practices which are unacceptable to the Department of Chemistry and Biochemistry, we have prepared an information seminar which, hopefully, will help you avoid a similar fate.

All students, *from any department or faculty*, who are taking any chemistry or biochemistry course are strongly urged to attend a Chemistry and Biochemistry Department seminar (and pass an on- line quiz) on the appropriate use of information sources and the academic code of conduct (University Calendar: Section 16.3.13). In certain courses, at the discretion of the professor, this may be a required element*. You need to attend the seminar and pass the quiz only once during your programme at Concordia to meet any such course requirement you may encounter.

The timing of these seminars will be announced in class and will be posted. They are usually scheduled near the beginning of term, before labs get started, to avoid timetable conflicts. Because classroom capacities are limited, you should sign up for one of the seminars on the sign-up sheet in the Departmental Office.

You will be provided with information about the on-line quiz when you attend the seminar, and you should not attempt the quiz before attending.

When you take, and pass, the quiz, this implies that you have understood the rules and accept, that if you infringe them, you cannot claim that you "did not know".

* Please check with the professor teaching each of your courses to find out their policy. If they have made the seminar and quiz a requirement in their course, and you have not completed this requirement by the time grades are submitted, you may be given a lower grade and/or "INC" (incomplete) notation until you do. If this happens to you, please be aware of the academic regulations for removing an incomplete notation - you must apply to complete, and there is a deadline and a fee (University Calendar: Section 16.3.6).

CHEM 205 General Chemistry I 3 credits

Instructors: P.H. Bird, G. Denes
Prerequisites: none
For: Mature Students and students who have not taken CEGEP level chemistry, students who wish to obtain some knowledge of chemistry or to continue in chemistry. This course, together with CHEM 206, is a prerequisite for all other courses in chemistry except CHEM 208 or CHEM 209.
Format: Lectures and laboratories, (Labs and tutorials alternate each week) **Basis of Grading:** Combination of tests, lab. work and final exam.
Description: This course is intended to provide students with a knowledge of basic concepts in chemistry. Among the topics discussed are stoichiometry; states of matter, atomic and molecular structure, the periodic table and periodicity and chemical bonding.

Note: Students in programmes leading to the B.Sc. degree may not take this course for credit to be applied to their programme of concentration.

CHEM 206 General Chemistry II 3 credits

Instructors: P.H. Bird
Prerequisites: CHEM 205
For: Same as CHEM 205
Format: Lectures and laboratories, (labs and tutorials alternate each week).
Basis of Grading: Combination of tests, lab. work and final exam.
Description: Thermochemistry, solutions and their properties, equilibrium, ionic equilibria, pH, buffers, kinetics, reaction mechanisms, other selected topics related to biochemistry, biology, and engineering.

Note: Students in programmes leading to the B.Sc. degree may not take this course for credit to be applied to their programme of concentration.

CHEM 208 Chemical Hazards in the Work Environment 3 Credits

Instructor: B. Pant
Prerequisites: none
For: Students not registered for a B.Sc.
Format: Lectures
Basis of Grading: Term paper, mid-term and final exams.
Description: An introduction to chemistry, chemical hazards and the social history of chemistry. Toxicity, combustion, corrosion, explosives, radiation and water reactive materials in the work environment are studied. An aim of the course is to help the student establish the chemical vocabulary and concepts necessary to understand the social impact of chemistry in relation to occupational health and safety. No previous knowledge of chemistry is assumed since the necessary quantitative and qualitative knowledge is developed throughout the course.

Note: This course may not be taken for credit by science students.

CHEM 209 Discovering Biotechnology 3 credits

Instructor: P. Joyce
Prerequisites: none
For: Non-science students, but is also open to science students
Format: Lectures
Basis of Grading: Term paper, midterm and final exam
Description: The course begins with an exploration of the roles of genes and proteins in life processes. It then proceeds to an examination of the basic scientific principles behind manipulation of biological molecules to produce desired changes. It considers specific applications of the technology to medicine, agriculture, and the environment. Economic and ethical issues raised by biotechnology are also examined. This course is intended for non-science students but is also open to science students.

NOTE: Students registered in a Biochemistry or Biology programme may not take this course for credit.

CHEM 212 Analytical Chemistry for Biologists 3 credits

Instructor: M. Lawrence, M. McClory
Prerequisites: CHEM 206; PHYS 206 and 226; MATH 205; or Cegep equivalent courses.
For: Degree programme in biology.
Format: Lectures and laboratory.
Basis of Grading: Class tests, final exam, lab work
Description: Chemical equilibria and titrations, treatment of analytical data, introduction to spectroscopy.

Note: This course may not be taken for credit by students registered in a Chemistry or Biochemistry programme.

CHEM 217 Introductory Analytical Chemistry I 3 credits

Instructors: Y. Gélinas
Prerequisites: CHEM 206; PHYS 206 and 226; MATH 203 or 205; or Cegep equivalent courses.
For: Degree programmes in chemistry and biochemistry.
Format: Lectures and laboratory.
Basis of Grading: Class tests, final exam, lab work
Description: An introduction to the basic theories involved in analytical chemistry, as demonstrated by acid/base, complexations and solubility product equilibria. The laboratory gives practice in the classical methods of gravimetric and volumetric methods of analysis, which are fundamental procedures used to obtain the most accurate results in modern analytical chemistry.

CHEM 218 Introductory Analytical Chemistry II 3 Credits

Instructors: Y. Gélinas, C. Skinner
Prerequisites: CHEM 217
For: Degree programmes in chemistry and biochemistry.
Format: Lectures and laboratory.
Basis of Grading: Class tests, final exam, lab work
Description: A continuation of the study of basic theories of analytical chemistry as applied to precipitation titration and redox equilibria. This is followed by an introduction to the more commonly used instrumental analytical techniques, including: potentiometry and molecular, atomic and fluorescence spectroscopy. The laboratory provides practice in the use of basic instrumentation.

CHEM 221 Introductory Organic Chemistry I 3 Credits

Instructors: L. Cuccia, P.G. Merle
Prerequisites: CHEM 206; or Cegep equivalent course.
For: All programmes in chemistry, biochemistry, and biology.
Format: Lectures and laboratory.
Basis of Grading: Midterm and final exams, laboratory work.
Description: Basic aspects of orbitals and their role in covalent bonding; delocalization of electrons. Alkanes: structure, nomenclature, isomerism, reactions. Introductory stereochemistry: enantiomers, diastereomers, conformers, Fischer and Newman projections, specification of chirality, E/Z-isomerism. Conformations of cyclic compounds. Alkyl halides: S_N1; S_N2; E1; E2 reaction mechanisms. Free-radical reactions, organometallic compounds. Chemistry of alkenes, alkynes, and dienes.

CHEM 222 Introductory Organic Chemistry II 3 credits

Instructor: S. Robidoux

Prerequisites: CHEM 221 or equivalent

For: All degree programmes in chemistry, biochemistry, and biology.

Format: Lectures and laboratory.

Basis of Grading: Laboratory work, midterm and final exams.

Description: Introduction to the use of IR and NMR spectroscopy for the identification of simple organic compounds. Benzene and aromatic compounds: aromaticity, electrophilic aromatic substitution, nucleophilic aromatic substitution, substituent effects. Chemistry of aldehydes and ketones: nucleophilic addition, oxidation, reduction, and condensation reactions, tautomerism. Chemistry of carboxylic acids and their derivatives. Chemistry of alcohols, ethers, and related compounds. Amines: basicity, reactions.

CHEM 234 Physical Chemistry I: Thermodynamics 3 credits

Instructors: M.F. Lawrence, R. Le Van Mao

Prerequisites: CHEM 206; PHYS 206 and 226; MATH 203 or 205; or Cegep equivalent courses.

For: Degree programmes in chemistry and biochemistry.

Format: Lectures, Problem Assignments, and Assigned Readings.

Basis of Grading: Midterm and final exams

Description: The properties of real gases; fugacities; first, second and third laws of thermodynamics; the Phase Rule, one- and two-component systems; real solutions, and partial molal properties.

CHEM 235 Physical Chemistry II: Kinetics of Chemical Reactions

3 credits

Instructors: R. Le Van Mao, D. Jack

Prerequisite: CHEM 234

For: Degree programmes in chemistry and biochemistry.

Format: Lectures and Laboratory.

Basis of Grading: Laboratory work, Midterm and final exams

Description: Mathematical treatment of experimental results; theories of reaction rates; unimolecular reactions; the steady-state approximation; factors influencing rates of reactions in solution; acid-base catalysis, catalysis by enzymes and the Michaelis-Menten mechanism; free-radical reactions; photochemical reactions; experimental methods and techniques.

CHEM 241 Inorganic Chemistry I : Introduction to Periodicity and Valence Theory

3 credits

Instructors: P.H. Bird

Prerequisites: CHEM 206; PHYS 206 and PHYS 226; MAHT 205 or Cegep equivalent courses.

For: Degree programmes in chemistry and biochemistry

Format: Lectures, problem sessions and laboratory

Basis of Grading: Assignments, mid-term and final exams, and laboratory work

Description: The structure of the atom, and its use in explaining the periodic table and properties of atoms; covalent bonding treatments - including Lewis Theory; the Valence Shell Electron Pair Repulsion Theory of structure, the valence bond and the molecular orbital theories of bonding. Crystal Field Theory applied to the structure and properties of transition metal complexes. Bonding theories of metallic materials and semi-conductors.

CHEM 242 Inorganic Chemistry II. Chemistry of the Main Group Elements 3 credits

Instructors: G. Denes
Prerequisites: CHEM 241
For: Degree programme in chemistry
Format: Lectures and laboratory
Basis of Grading: Assignments, mid-term and final exams and laboratory work
Description: A survey of the properties and reactions of: hydrogen; Group I, lithium to cesium; and Group 2, beryllium to radium; including the theory of ionic bonding and structure. The descriptive chemistry of Group 13, boron to thallium; Group 14, carbon to lead; Group 15, nitrogen to bismuth; Group 16, sulphur to polonium; Group 17, the halogens; and Group 18, the chemistry of the noble gases.

CHEM 271 Biochemistry I 3 credits

Instructors: M.J. Kornblatt, J. Turnbull
Prerequisite: CHEM 221; CHEM 222 previously or concurrently
For: Degree programmes in chemistry and biochemistry
Format: Lectures, tutorials, and laboratory
Basis of Grading: Laboratory and tutorial work, mid-term and final exams.
Description: This course is an introduction to the essentials of biochemistry. Topics discussed are protein structure, enzymology, carbohydrate metabolism, electron transport, integration and regulation of metabolism.

CHEM 312 Intermediate Analytical Chemistry 3 credits

Instructor: C. Skinner
Prerequisite: CHEM 218
For: Degree programmes in chemistry and biochemistry
Format: Lectures and laboratory
Basis of Grading: Mid-term and final exams, laboratory work
Description: This course is a continuation of Chem. 218 with emphasis on instrumental analysis. Techniques discussed include emission spectroscopy; X-ray spectroscopy; voltammetry and polarography, amperometric titrations; coulometry and coulometric titrations; conductometry; chromatography with particular emphasis on gas chromatography and high performance liquid chromatography. Laboratory work is done concurrently and provides experience in the techniques discussed in lectures.

CHEM 324 Organic Chemistry III : Organic Reactions 3 credits

Instructor: S. Robidoux
Prerequisite: CHEM 222 or equivalent, CHEM 235 previously or concurrently.
For: Degree programmes in chemistry and biochemistry
Format: Lectures and laboratory
Basis of Grading: Mid-term and final exams, laboratory work.
Description: This course is a mechanistic survey of reactions of major synthetic utility. It deals with reaction mechanisms and the importance of reactive intermediates such as carbocations, carbanions, radicals and carbenes.

CHEM 325 Organic Chemistry IV : Organic Structure and Stereochemistry 3 credits

Instructors: H.M. Muchall, L.A. Cuccia
Prerequisites: CHEM 222 or equivalent
For: Degree programmes in chemistry and biochemistry
Format: Lectures and laboratory
Basis for Grading: Mid-term and final exams, laboratory work.
Description: Organic structure and stereochemistry including the relationship of stereochemistry to physical properties and chemical reactivity. Determination of organic structure and stereochemistry by chemical and spectroscopic means. Introduction to molecular symmetry.

CHEM 326 Natural Products 3 credits

Instructor: S. Robidoux
Prerequisite: CHEM 324 previously or concurrently
For: Optional course
Format: Lectures
Basis of Grading: Mid-term and final exams
Description: The structures, mechanisms of action and biosynthetic origins of biologically important compounds such as fatty acids, polyketides, steroids, alkaloids and beta-lactam antibiotics are discussed. The role of traditional organic chemistry in the development of modern biochemistry and biotechnology is illustrated with examples from medicine and agriculture.

CHEM 327 Organic Chemistry of Polymers 3 credits

Instructor: P.G. Merle
Prerequisite: CHEM 222, or equivalent.
For: Optional course
Format: Lectures and problem sessions
Basis of Grading: Mid-term and final exams
Description: Introduction to the fundamental aspects of polymers and polymerization. Methods of preparation, reaction mechanisms of polymer synthesis including condensation polymerization; addition polymerization: free radical, anionic, cationic; Ziegler-Natta (heterogeneous) and single-site (homogeneous) coordination polymerisation. Principle methods for the characterization of polymers and main properties and applications.

CHEM 333 Introduction to Quantum Theory 3 credits

Instructors: G.H. Peslherbe
Prerequisites: CHEM 235
For: Degree programmes in chemistry and biochemistry
Format: Lectures
Basis of Grading: Mid-term, final exams and assignments
Descriptions: The course introduces the students to the concept of quantum mechanics and the electronic structure of atoms and molecules. Topics include the origins and postulates of quantum theory, the Schrodinger equation and applications to simple systems such as the harmonic oscillator, rigid rotor and the hydrogen atom. The course looks at the quantum mechanical treatment of the chemical bond and provides an introduction to spectroscopy.

CHEM 335 Biophysical Chemistry 3 Credits

Instructor: C. DeWolf
Prerequisites: CHEM 235, CHEM 271
For: Degree programme in biochemistry .
Format: Lectures and laboratory.
Basis of Grading: Mid-term, final exams and laboratory work
Description: This course examines the physical basis, organization and structures of biomembranes and biologically relevant systems, and intermolecular interactions (e.g. ligand binding). Both fundamental theory and techniques used to characterize these physical properties are covered.

CHEM 341 Inorganic Chemistry III : The Transition Elements
3 credits

Instructors: P.H. Bird
Prerequisites: CHEM 217, 218, 241, 242
For: Degree programme in chemistry
Format: Lectures and laboratory
Basis of Grading: Assignments, mid-term, final exam and laboratory work
Description: Theories of bonding in transition metal complexes, including ligand field theory, applied to structure, physical properties, and reactivity of transition metal complexes: organometallic chemistry and catalysis. Metals in biological systems.

CHEM 375 Biochemistry II 3 credits

Instructors: P. Joyce, M.J. Kornblatt and J. Powlowski
Prerequisite: CHEM 222, 271
For: Degree programme in biochemistry
Format: Lectures and laboratory
Basis of Grading: Mid-term and final exams, lab. work and reports.
Description: This course surveys selected pathways in intermediary metabolism including their regulation and physiological significance; the urea cycle; fatty acid oxidation; biosynthesis of nucleosides, tetrapyrroles, carotenoids, cholesterol and steroidal hormones. The biosynthesis of vitamins and cofactors and the metabolism of selected amino acids may also be discussed.

CHEM 393 Spectroscopy and Structure of Organic Compounds
3 credits
Instructor: H. Muchall, S. Robidoux
Prerequisites: CHEM 222
For: Degree programmes in chemistry and biochemistry
Format: Lectures and laboratory
Basis of Grading: Mid-term, final exams and laboratory work
Description: This course will discuss the identification of organic compounds using methods based on electronic, vibrational, nuclear magnetic resonance and mass spectroscopies. In each case, there will be an introduction to the principles of the spectroscopy and a discussion of how its spectra vary with structure. Particular emphasis will be on the UV-visible spectra of conjugated molecules, the identification of functional groups by IR spectroscopy, the use of NMR spectroscopy, including 2D methods, for the determination of stereochemistry, and the use of mass spectrometry for ascertaining molecular constitution. The use of computer simulation and information retrieval for structure determination will be introduced.

Note: Students who have received credit for CHEM 328 may not take this course for credit.

CHEM 415 Analytical Separations 3 credits

Instructor: C. Skinner
Prerequisites: CHEM 312
For: Optional Course
Format: Lectures
Basis of Grading: Midterm and final exams, possibility of one lab
Description: High performance liquid separations on an analytical (non-preparative) scale are surveyed. Fundamental separation mechanisms and application of the techniques are discussed. Emphasis is placed on capillary electrophoretic separations of biologically relevant analytes which include peptides, proteins and nucleic acids.

CHEM 419 Independent Study and Practicum 6 credits

Instructor: The faculty
Prerequisites: Must have completed the 45-credit Core programme, or equivalent, with a GPA of 2.00 (C) or better, must have obtained acceptance by a supervisor, and confirmation by the Coordinator of Senior Theses (Dr. C. DeWolf). This must be done before registering in the course.
For: Specialization in chemistry
Format: Laboratory and conferences
Basis of Grading: Work is presented to the Department in the form of a scientific poster.
Description: In collaboration with and under the direction of a faculty member, the student carries out independent study and practical work on a problem chosen from the student's area of concentration.

Note: Student must have completed the 45-credit Core Programme, or equivalent, with a cumulative G.P.A. of 2.00 before registering for CHEM 419.

CHEM 421 Physical Organic Chemistry 3 credits

Instructor: TBA
Prerequisites: CHEM 324 or 325; CHEM 235
For: Optional course
Format: Lectures
Basis of Grading: Assignments and final exam
Description: Determination of organic reaction mechanisms using kinetics, activation parameters, acid-base catalysis, Bronsted catalysis law, solvent effects, medium effects, isotope effects, substitutent effects and linear free energy relationships.

CHEM 424 Organic Synthesis 3 credits

Instructor: S. Robidoux
Prerequisite: CHEM 324
For: Optional course
Format: Lectures
Basis of Grading: Mid-term and final exams
Description: This course is concerned with synthetic strategy and design. Applications of modern synthetic methods and reagents are exemplified by synthesis of natural products, peptides, nucleic acids, and novel chemotherapeutic agents.

CHEM 431 Computational Chemistry for Chemists and Biochemists
3 credits
Instructor: G.H. Peslherbe
Prerequisite: CHEM 333
For: Optional course
Format: Lectures
Basis of Grading: Mid-term and final exams
Description: This course presents the concepts, tools, and techniques of modern computational chemistry, and provides a very broad overview of the various fields of application across chemistry and biochemistry. The course is divided into two parts: 1) Molecular structure, which covers molecular mechanics and elementary electronic structure theory of atoms and molecules; and 2) Chemical reactivity, which covers applications of quantum chemistry and molecular dynamics techniques to studies of chemical reactions. The applications discussed include organic molecules and their reactions, peptides and proteins, drug design, DNA, polymers, inorganics, and materials. The course includes a practical component where students acquire hands-on experience with commonly used computational chemistry computer software.

Note: Students who have received credit for this topic under a CHEM 498 number may not take this course for credit.

CHEM 445 Industrial Catalysis 3 credits
Instructor: R. LeVan Mao
Prerequisite: CHEM 234 and 235
For: Optional course
Format: Lectures
Basis of Grading: Mid-term, final exam and assignments.
Description: Basic and recent concepts in catalysis are described with particular emphasis on heterogeneous catalysis. The technical, economic and environmental aspects of industrial catalysis are covered. The processes to be studied are chosen from the petroleum industry, the natural gas and coal processing industry, and the production of thermoplastics and synthetic fibers. The course ends with a rapid survey of problems associated with the treatment of industrial pollutants and with catalytic converters.

CHEM 450 Research Project and Thesis 6 credits

Instructor: The faculty

Prerequisite: Third year standing in Honours Chemistry (Completed 60 credits), or permission of the Department (provided the student has a grade point average of 3.00 (B) or better, for all Core Programme Courses).

For: Honours programmes or students with permission

Format: Laboratory and conferences

Basis of Grading: Written thesis and oral defence of work before the faculty.

Description: The student works on a research project, in the student's area of concentration, selected in consultation with and conducted under the supervision of a faculty member of the Department; and writes a thesis on the results. The project is also the subject of a presentation before a committee.

Note: Students planning to take this course must consult with the Coordinator of Senior Theses, (Dr. C. DeWolf) as early as possible the year before the final year.

CHEM 470 Environmental Biochemistry 3 credits

Instructor: TBA

Prerequisites: CHEM 271, CHEM 375 and BIOL 367

For: Optional course in biochemistry programmes

Format: Lectures

Basis of Grading: Mid-term, final exam, and assignments.

Description: This course examines the biochemical effects of environmental stresses on organisms, and adaptations that allow organisms to face these stresses. Emphasis is placed on biochemical responses to toxic compounds such as aromatics, halogenated aliphatics, drugs, and heavy metals. Other topics may include adaptions to stresses such as temperature extremes, pathogens, and ionising radiation. Applications to related biotechnological processes are also considered.

Note: Students who have received credit for CHEM 498P may not take this courses for credit.

CHEM 471 Enzyme Kinetics and Mechanism 3 credits

Instructor: J. Turnbull
Prerequisites: CHEM 271; (60 credits completed)
For: Optional course in biochemistry programmes
Format: Lectures
Basis of Grading: Mid-term, final exams, and assignments. (No supplementals allowed in this course.)
Description: Steady state kinetics, including the use of initial velocity studies and product inhibition to establish a kinetic mechanism; non-steady-state kinetics, isotope effects, energy of activation, etc.; detailed mechanisms of selected enzymes.

CHEM 472 Chemical Toxicology 3 credits

Instructor: TBA
Prerequisites: CHEM 271
For: Optional course
Format: Lectures
Basis of Grading: Assignments, final exam
Description: Introduction to the general principles of toxicology with emphasis on the toxic effects of chemicals in humans. Dose-response relationship, types and routes of exposure, absorption and disposition of toxic substances, toxicokinetics, types of toxic response and factors affecting toxic response. Toxicity testing, risk assessment and interpretation of toxicological data.

CHEM 477 Advanced Laboratory in Biochemistry 3 credits

Instructors: M.J. Kornblatt, J. Turnbull and J. Powlowski
Prerequisite: CHEM 375; BIOL 368 previously or concurrently
For: Programmes in biochemistry
Format: Tutorial and laboratory
Basis of Grading: Laboratory work, quizzes and final exam
Description: Theory and practice of techniques in enzymology and protein chemistry, including steady-state and stopped-flow enzyme kinetics, ligand binding, immunological techniques, proteomics, computer modelling, and chemical modification of proteins.

CHEM 478 Hormone Biochemistry 3 credits

Instructor: J. Fraser
Prerequisites: CHEM 375
For: Optional course
Format: Lectures
Basis of Grading: Mid-term and final exams
Description: This course deals with an in-depth study of the vertebrate hormones and involves a study of the precise chemical structure and properties of each hormone, its biosynthesis and mode of secretion from the cell. The circulating form of the hormone is examined, as well as the nature of the hormone receptor. The cellular mechanism of action and the relationship of the hormone's action to the intact animal are investigated.

CHEM 481 Bioinorganic Chemistry 3 credits

Instructor: A. English
Prerequisites: CHEM 241, 271
For: Optional course
Format: Lectures
Basis of Grading: Mid-term and final exams
Description: Role of metals in biochemical systems. Essential trace elements, zinc enzymes, oxygen transport and storage, metalloproteins and biological electron transfer, structure-function relationships in heme enzymes, nitrogen fixation; model compounds for metalloproteins and metalloenzymes.

CHEM 493 Magnetic Resonance Spectroscopy 3 credits

Instructor: TBA
Prerequisite: CHEM 222 or equivalent
For: Optional course
Format: Lectures
Basis of Grading: TBA
Description: This course is designed to provide the background in magnetic resonance theory necessary to understand modern high-resolution NMR experiments and instrumentation. The basic theory in the introductory section also applies to electron spin resonance (ESR). Relaxation and through-bond and through-space interactions, and experiments to investigate them, are considered. Spin manipulations and behaviour in multiple-pulse, Fourier transform NMR techniques used for common spectral editing and two-dimensional experiments are discussed.

CHEM 494 Mass Spectrometry 3 credits

Instructor: A. English
Prerequisite: CHEM 235
For: Optional course
Format: Lectures
Basis of Grading: TBA
Description: Applications of mass spectrometry in chemistry, biochemistry and biology. Topics to be covered will include: ionization methods (electrospray, matrix assisted laser desorption, electron impact, and chemical ionization); mass analysers; tandem mass spectrometry; interpretation of mass spectra of small molecules and biomacromolecules.

Note: Students who have received credit for this course under a CHEM 498 number may not take this course for credit.

CHEM 495 Modern Spectroscopy 3 credits

Instructor: J. Capobianco
Prerequisites: CHEM 333
For: Optional course
Format: Lectures and laboratory
Basis of Grading: Mid-term, final exams
Description: This course demonstrates how quantum theory applies to the measurement of absorption and emission spectra of atoms and molecules. The course examines rotational, vibrational, and electronic spectroscopy. Photoelectron and related spectroscopies, lasers and laser spectroscopy.

CHEM 498 Advanced Topics in Chemistry 3 credits

Courses under this number and heading are scheduled as the demand and opportunity arises. There is no guarantee that a particular topic will be scheduled in any particular year. Students are advised to consult the schedule.

Some topics that have been offered in the past few years are noted below:

- Biochemistry III (498A)
- Neurochemistry (498B)
- Crystallography for Solid State Chemists (498E)
- Mossbauer Spectroscopy & Mag. Prop. (498F)
- Irreversible Thermodynamics (498H)
- Advanced Quantum Chemistry (498 L)
- Electrochemistry (498M)
- Organic Photochemistry (498N)
- Advanced Instrum. Analysis (498O)
- Statistical Mechanics (498Q)
- Phys. Methods in Chemistry (498R)
- Reactive Intermediates (498S)
- Supramolecular Chemistry (498U)
- Aquatic Chemistry (498V)
- Non-Equilibrium Statistical Mechanics (498X)
- Interfacial Phenomena (498Y)